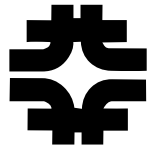


# Booster Collimators

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Todd Sullivan

Bill Pellico

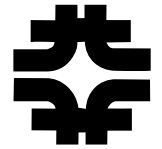
Proton Source - Booster

Fermilab

March 30, 2005

# Outline

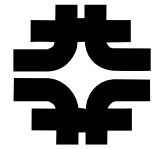
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- **History of Collimators**
- **Hardware Overview**
- **Operational Experience**
- **IPM and TBT Data**
- **BLM Data**

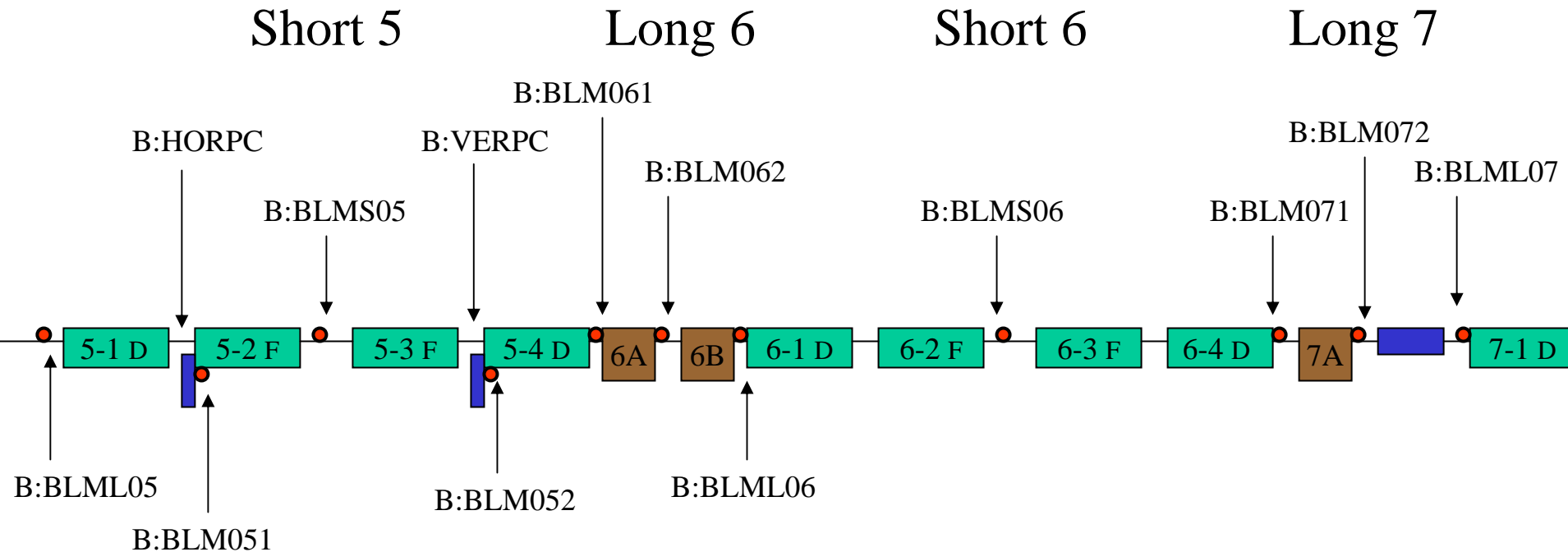
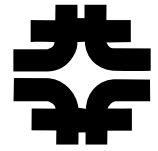
# History

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- Collimator Design Paper:  
“Commissioning of the Beam Collimation System at the Fermilab Booster.”  
Drozhdin, Kasper, Lackey, Mokhov, Prebys, Syphers
- Motion control hardware AD Controls Dept
- ACNET Application program Dean Still
- Installed October Shutdown 2003
- Commissioned spring of 2004
- Operational since April 2004

# Booster Tunnel Map



B:S5PCH - upstream mini-straight of Period 5

B:S5PCV - downstream mini-straight of Period 5

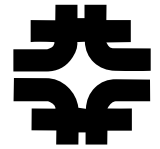
6A - upstream end of Long 6

6B - downstream end of Long 6

7A - upstream end of Long 7

# Hardware Overview

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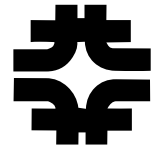


Tunnel Hardware: Two copper primary foils and three 12 ton secondary collimators

1. Horizontal primary located at upstream period 5 mini straight. Vertical primary located at downstream period 5 mini straight.
2. Two secondary collimators at Long 6
3. One secondary collimator is located at Long 7
  - A small collector downstream of Long 7 Collimator

# Primary Collimators

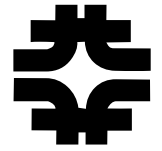
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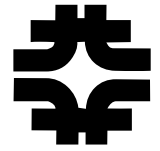
- Initial design used a 12 mils carbon for primary foil.
- A 15 mils copper foil was added to the carbon for higher energy collimation testing.
- Presently we run using only the 15 mils copper foil.
- Both primaries are attached to wire scanner assemblies for motion control.
- Produce an out-scattering of particles when intercepting beam halo.

# Primary Collimator

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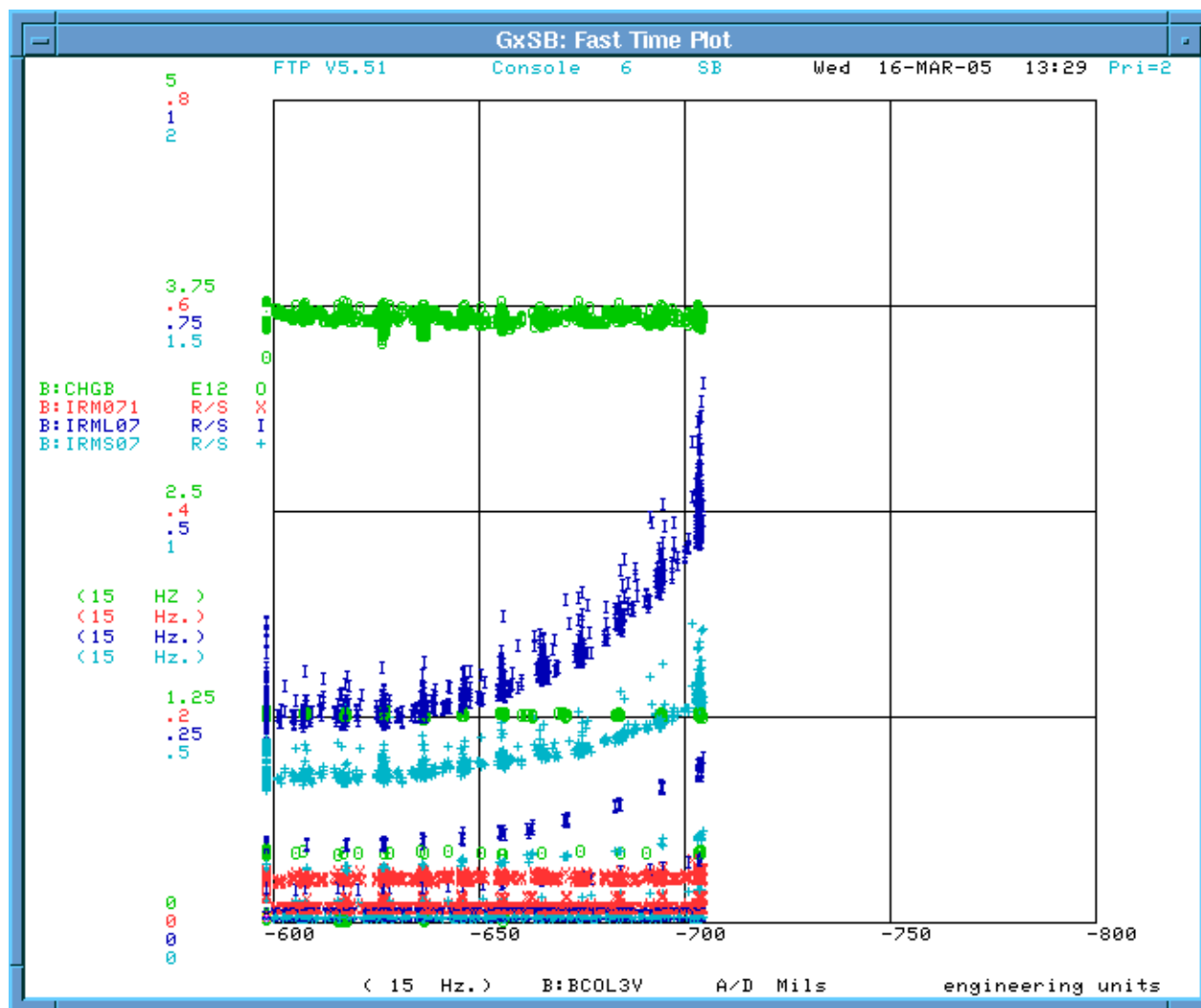


# Secondary Collimators

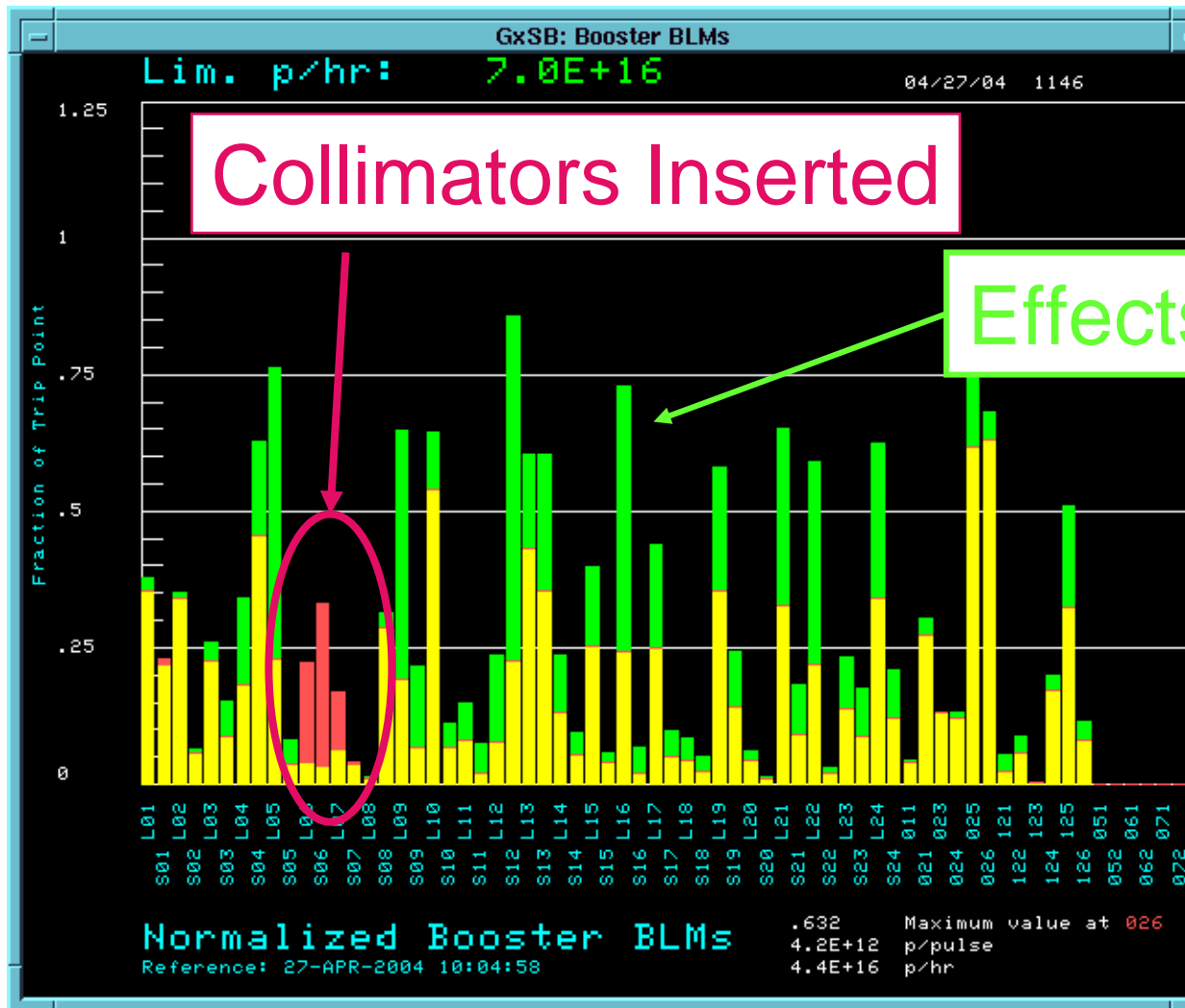
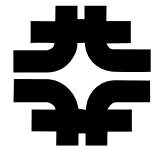


- Four Separate Degrees of Freedom:
  - Vertical
  - Horizontal
  - Yaw
  - Pitch
- All four motorized with stepper motors.
- One complete collimator with stand weighs 14.6 tons.

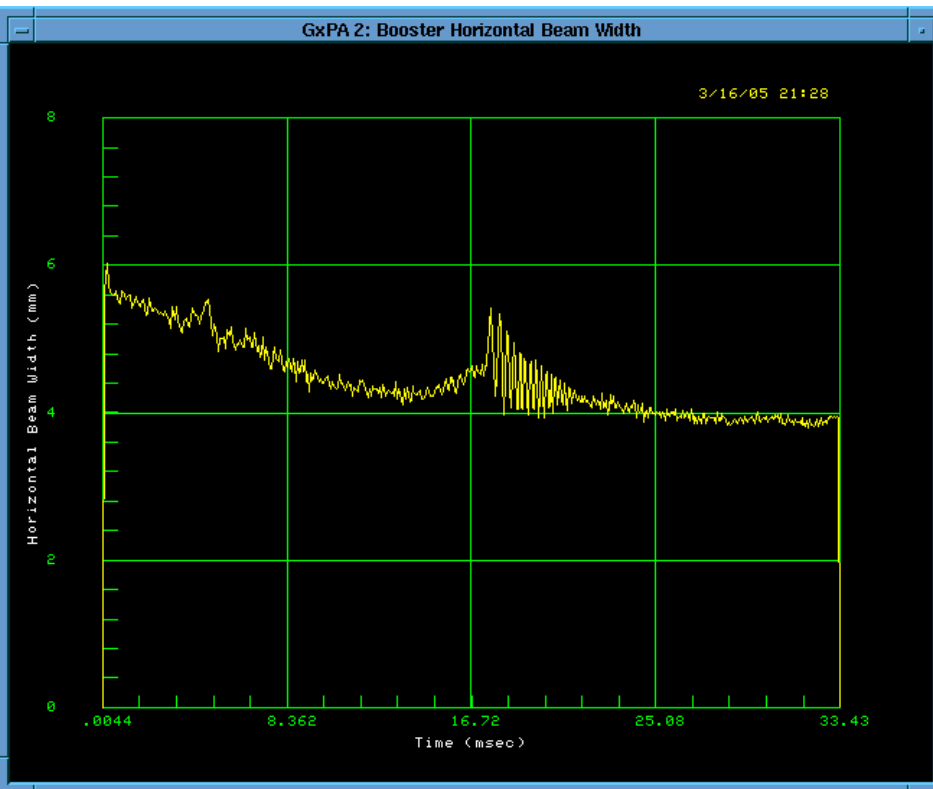
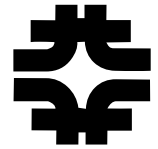
# Collimator Scan



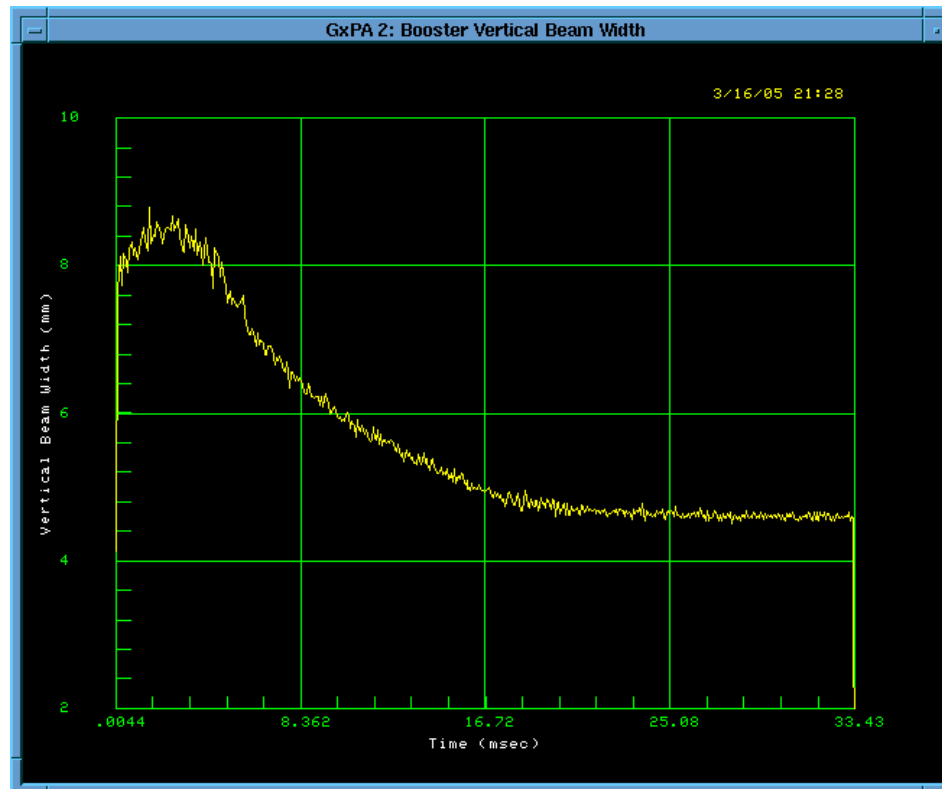
# Effects of Collimators on Ring Losses



# IPM DATA - Beam Width

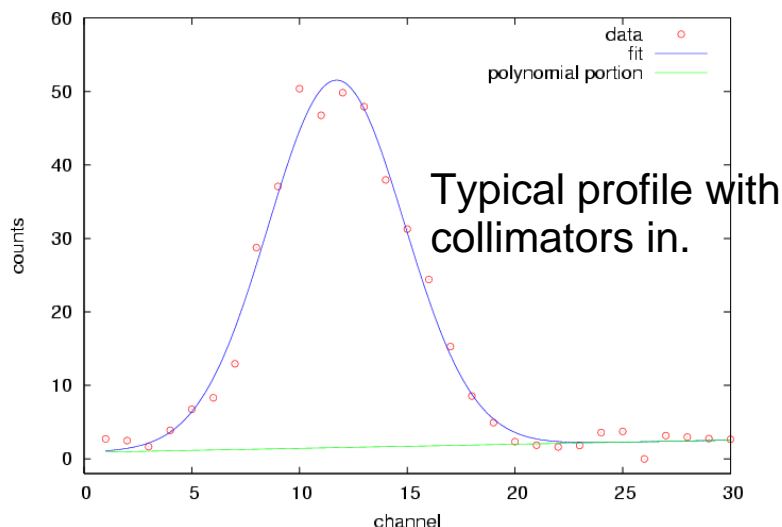
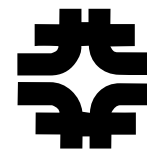


Horizontal



Vertical

# IPM Profiles Fit to a Gaussian+Linear Function



$$G \equiv \int (\text{Gaussian term})$$

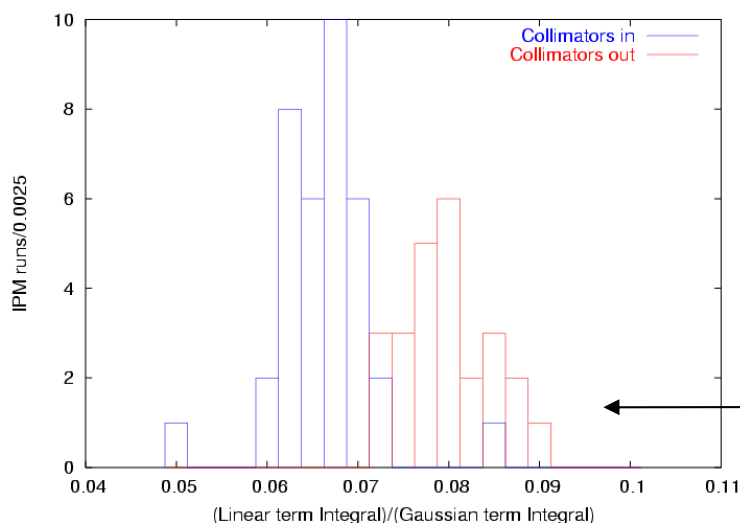
$$L \equiv \int (\text{Linear term})$$

L/G measures non-Gaussian tails (halo)

We collected IPM data for many cycles with and without the collimators.

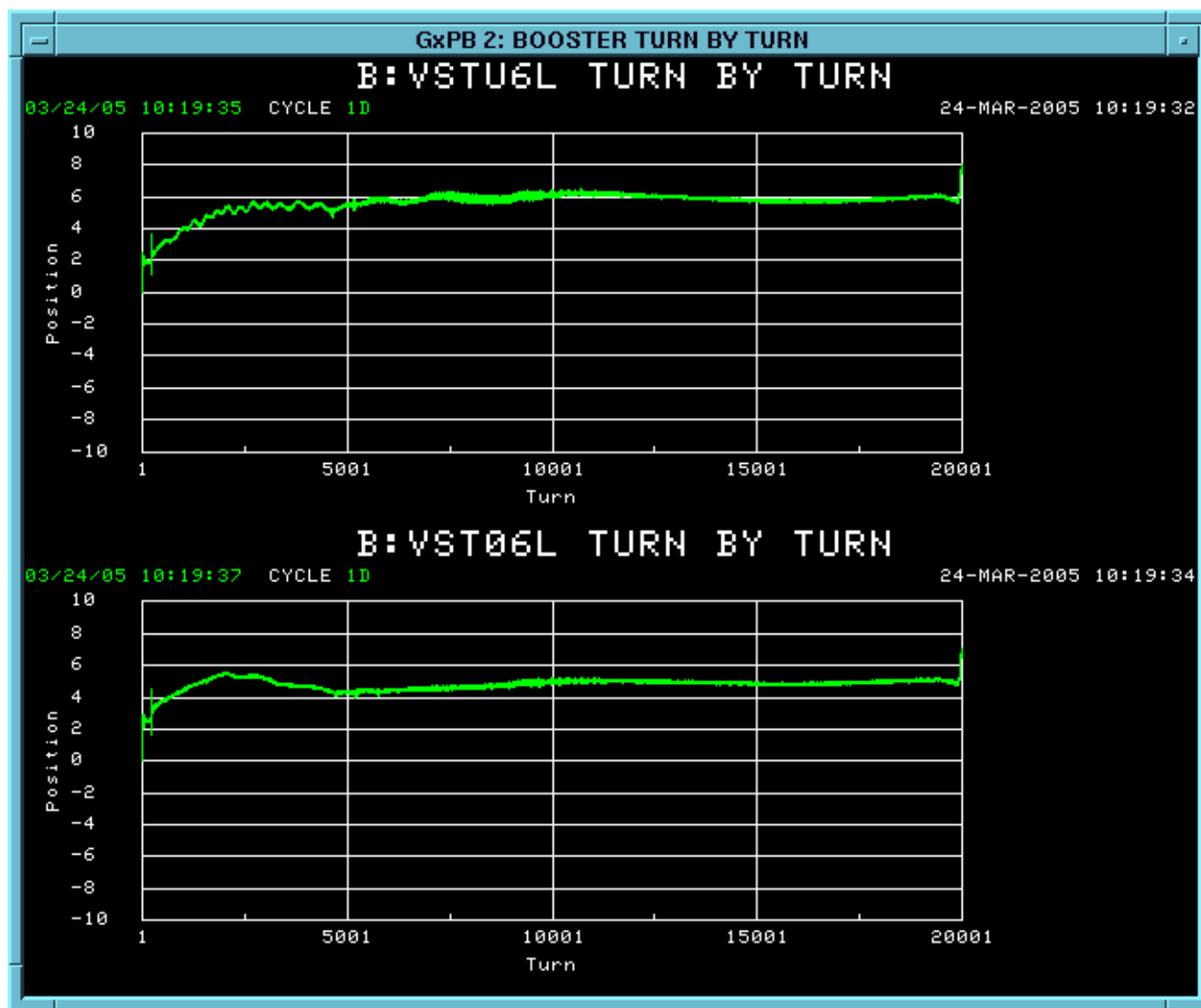
Average L/G for the last 500 turns in Booster cycle.

L/G **without collimators** is significantly larger than L/G **with collimators**.

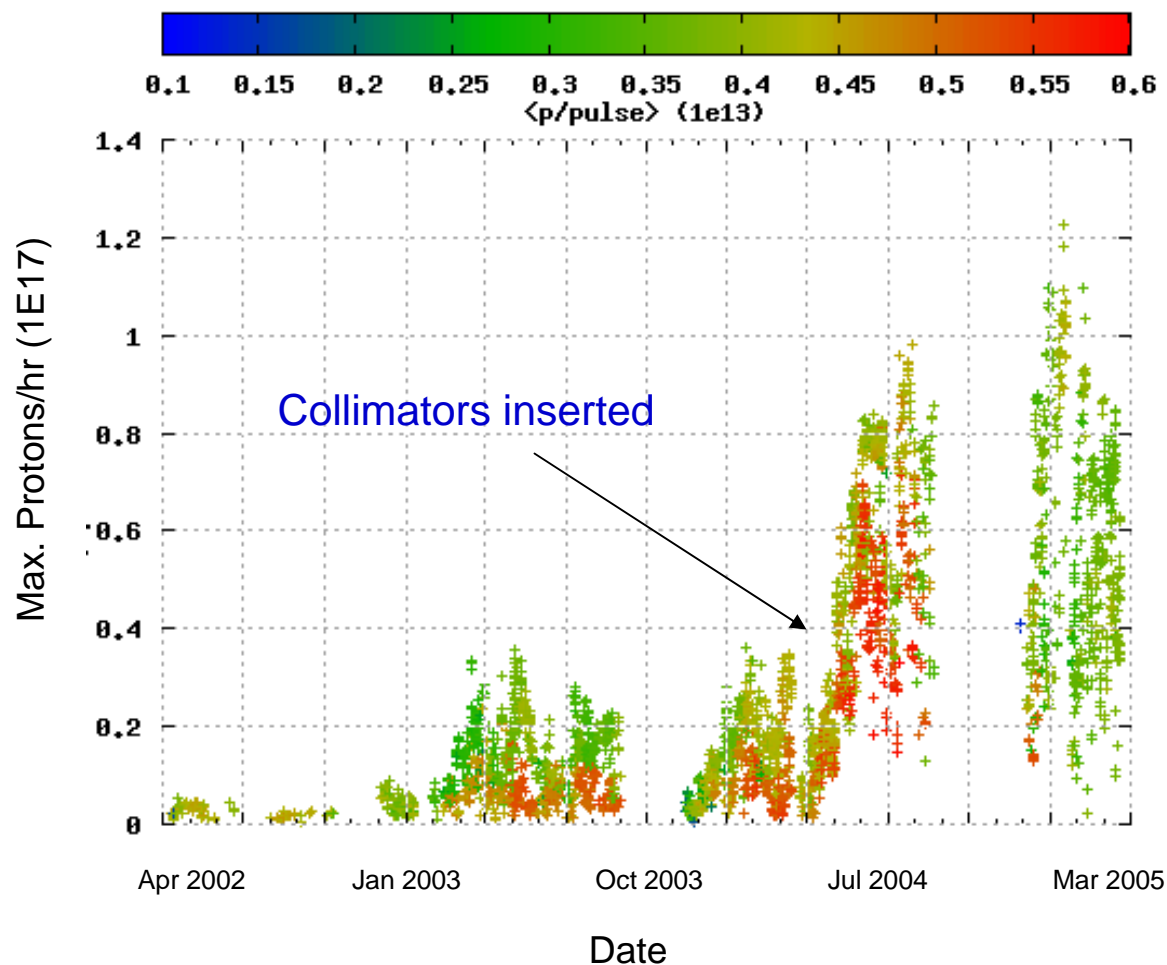


J. Amundson, P. Spentzouris, CD/CEPA

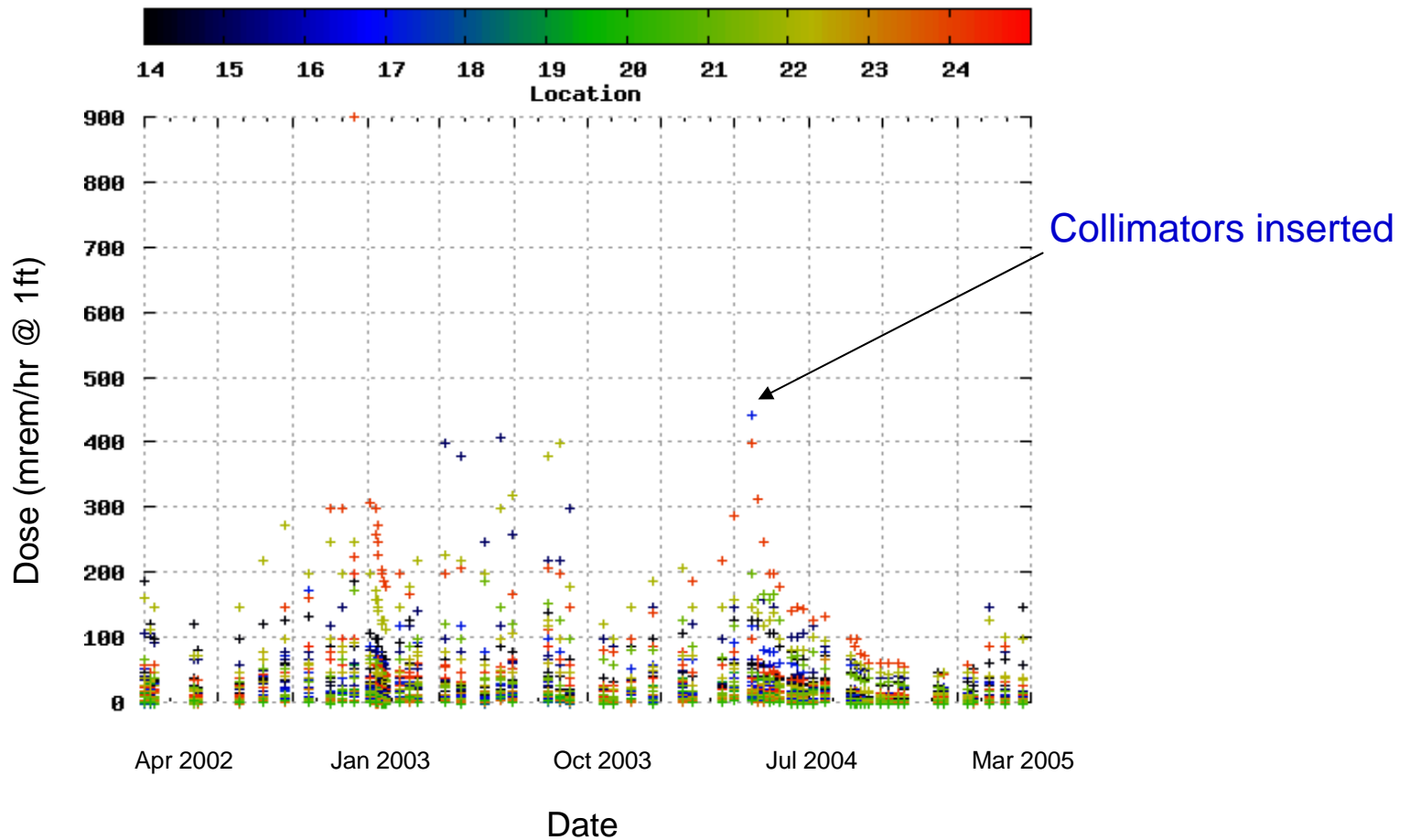
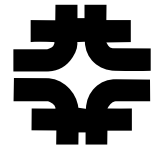
# Vertical TBT at L6



# Maximum Protons/hr Limit

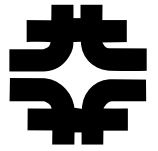


# Booster RF Activation Data



# Conclusion

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- Collimators have significantly reduced losses in areas of concern allowing an increase in the maximum extracted protons/hr.